5399

BALLANTINE LABORATORIES, Inc.

INSTRUCTIONS FOR

SENSITIVE PEAK-TO-PEAK ELECTRONIC VOLTMETER

MODEL 305

BOONTON, NEW JERSEY

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SPECIFICATIONS

BALLANTINE MODEL 305 PEAK-TO-PEAK VOLTMETER

Frequency Range for Sinusoidal Waves
10 cycles to 150,000 cycles

Pulse Width
Minimum 3 usec; Maximum 250 usec

Minimum Pulse Rise and Fall Times
1 usec

Minimum Pulse Repetition Rate
20 Pulses per second

Accuracy
3% for sinusoidal waves
5% for pulses

Voltage Range
.001 volts to 1000 volts peak-to-peak in 6 decade ranges
(.01, .1, 1, 10, 100, and 1000 volts full scale)

Input Impedance

Range Switch Setting	Input Impedance
.01 and .1	2 megohms shunted by 15 uuf
1	2.2 megohms shunted by 8 uuf
10	2.02 megohms shunted by 8 uuf
100 and 1000	2 megohms shunted by 8 uuf

Scales
Logarithmic voltage scale (illuminated) reading from 1 to 10;
Auxiliary scale in decibels from 0 to 20.

Amplifier Characteristics
Maximum voltage gain approximately 75 db adjustable by means of range switch to 55, 35, and 15 db. Output impedance 0 to 100 ohms in series with .1 uf. Maximum output voltage 150 volts peak-to-peak. Maximum output current 3 milliamperes peak-to-peak. Flat within 1 db.

Power Supply
115 volts, 50-60 cycles, 50 watts. A 5% change in power line voltage will not affect accuracy by more than 1/2%.

Tubes
Four Type 6AU6; two Type 6AL5; two Type 12AU7; one Type 0A2; one Type 6X4.
All tubes supplied.

Dimensions
6" high, 6-3/4" wide, 11-5/8" long.

Weight
12 pounds

INSTRUCTIONS

for

BALLANTINE MODEL 305 PEAK-TO-PEAK VOLTMETER

GENERAL - This instrument is designed especially to measure the peak-to-peak values of narrow voltage pulses having a minimum width of 3 microseconds with a minimum rise time of microsecond and a minimum repetition rate of 20 cycles per second.

Its voltage range is from .001 volts to 1000 volts peak-to-peak and its accuracy at any point on the scale is 5% for pulses and 3% for sinusoidal waves from 10 cycles to 150,000 cycles.

By means of a six decade range selector switch the entire voltage range may be read on a single logarithmic voltage scale reading from 1 to 10. The markings on the range selector switch refer to full scale voltages.

The indicating meter also has a uniform decibel scale numbered from 0 to 20 decibels for use when measuring sinusoidal waves. The zero of the decibel scale is arbitrarily arranged for maximum usefulness so as to correspond to 1 on the voltage scale.

A coaxial AC OUTPUT socket permits the amplifier section of the voltmeter to be used as a flat pre-amplifier with gains of about 15, 35, 55, or 75 db, depending on the setting of the range switch.

GENERAL CIRCUIT DESCRIPTION - The voltmeter employs a resistance-capacitance attenuator and two feedback amplifiers followed by a peak-to-peak responding rectifier circuit consisting of four stages.

The first stage of the rectifier circuit is a full wave detector responding to the peak positive and negative excursions of the input wave. The charging time constant of the input circuit is relatively small so that

it responds faithfully to rapid variations in amplitude. Since the output impedance of the first stage is quite high, a dual triode stage is used as an impedance step-down repeater amplifier to drive a second duo-diode rectifier. The second diode circuit has a long discharging time constant so that any ripple voltage is reduced to negligible proportions. The dc output voltage of this second rectifier thus truly represents the peak-to-peak voltage of the signal. The final twin triode delivers a current proportional to this dc voltage into a low resistance indicating instrument.

The amplifier which precedes the meter rectifier circuit serves two purposes. It provides amplification of small voltages under measurement and also functions as an impedance transformer. The input impedance of the amplifier is about 2 megohm while the output impedance preceding the meter rectifier is in the order of 100 ohms. The latter value is subject to some variation over the frequency spectrum, but as far as the peak-to-peak rectifier circuit is concerned, the amplifier output impedance is negligibly small. This feature is essential to the rapid response of the rectifier to steep wave fronts and is an important characteristic of the instrument. When the amplifier is employed separately, the low output impedance permits freedom and convenience in attaching leads to associated equipment through the reduction of capacitance loading effects.

OPERATION - The instrument is supplied with tubes and is ready to operate as received. It is necessary only to plug the line cord into the specified ac power source and to turn on the switch marked ON-OFF. The illuminating lamps incorporated in the indicating meter serve as a pilot light to indicate when the power is on.

The input terminal marked GND is connected to the case of the voltmeter. In order to avoid the introduction of extraneous voltages between

the two points whose potential difference is under measurement, the input terminal marked (-) (ground), whenever possible, be connected to the ground of the circuit in which a voltage is being measured.

In order to avoid extraneously induced voltages when operating on the more sensitive ranges, the input leads to the voltmeter should be as short as possible and should be shielded if the consequent increase in capacitance can be tolerated.

The voltage under measurement is easily determined by reference to the range switch position and the reading on the simple voltage scale. The position of the range switch indicates the voltage input to yield full-scale deflection of the indicating meter.

INPUT IMPEDANCE - The input impedance of the voltmeter depends somewhat on the setting of the range switch as shown by the following table:

Range Switch Setting	Input Impedance
.01 and .1	2 meg shunted by 15 uuf
1	2.2 meg shunted by 8 uuf
10	2.02 meg shunted by 8 uuf
100 and 1000	2 meg shunted by 8 uuf

Any dc component of the wave under measurement is kept out of the instrument by means of a series blocking capacitor of 600 volts rating in the input circuit.

AC OVERLOAD CHARACTERISTICS - The amplifier circuits are designed to saturate promptly when the voltage exceeds the full scale indication of the meter, thus protecting the meter movement.

The instrument will stand alternating current overloads of at least 200 to 1 on all ranges except the two highest. On these two ranges the maximum safe voltage is 2000 volts.

MAXIMUM DC CONTENT OF INPUT VOLTAGE - The maximum dc voltage permissible is 600 volts.

EFFECT OF WAVEFORM - The Model 305 yields an indication proportional to the total voltage swing (from positive to negative) of the input wave. Since it is responsive to short, narrow peaks, it will indicate minor imperfections such as small transients and overshoots on an otherwise flat-topped wave such as may be caused by over-compensation in square wave generators or amplifiers. For a sinusoidal wave input, the indication is 2.83 times the rms value.

USE AS AN AMPLIFIER - By turning the switch marked METER - AC OUTPUT to the AC OUTPUT position the Model 305 may be used as a stable high-gain pre-amplifier. The amplifier output socket is designed for a Jones coaxial plug Type P-101-3/8", one of which is supplied with the instrument and which is attached to the output socket when shipped.

When the range switch is set for the .01 range, the gain of the amplifier is about 75 db which gain may be reduced to either 55, 35, or 15 db by setting the range switch to the .1, the 1, or the 10 setting respectively. The maximum undistorted voltage output of the amplifier is 150 volts peak-to-peak when the external load is 30,000 ohms or greater. When the load is less than 30,000 ohms the maximum voltage output is limited by the maximum peak current output which is 3 milliamperes. The minimum resistive load which can be fed by the amplifier is about 1000 ohms. The output impedance of the amplifier is 100 ohms or less.

The ratio of the maximum undistorted output level of the amplifier to the combined hum and noise level at the output is 50 db at maximum gain and 70 db at other gain settings. The hum and noise level is equivalent to less than 10 microvolts in series with the grid of the input tube.

CURRENT MEASUREMENTS - The voltmeter may be readily converted to a sensitive direct-reading peak-to-peak milliammeter (in circuits where it is permissible to ground one side of the meter) by connecting a known value of resistance across the input terminals. The type 00C resistors described in our general catalog are ideal for this purpose. The minimum current values listed for Model 130 and 304 apply to Model 305 except the values are peak-to-peak. The maximum current values in the table may be exceeded for Model 305 depending on the duty cycle of the source current wave.

SERVICING - Servicing of this instrument by the user is not recommended except as described below. If trouble develops which cannot be corrected by following the procedures outlined below, it is recommended that the instrument be returned to us for servicing. Before returning the instrument, please describe the trouble by letter to us, and we could send shipping instructions.

SCALE RANGE ADJUSTMENT - Scale range adjustment is made by means of a screwdriver adjustment accessible through a hole marked RANGE ADJ on the right-hand side of the panel. When the scale range adjustment is properly made, a voltage which produces a scale reading of 10 will, when reduced by 90% (i.e. in the ratio of 10 to 1), produce a scale reading of 1. Ordinarily no adjustment should be necessary except at infrequent intervals, but if some discrepancy is noted an adjustment accurate to approximately 1% may be made as follows:

(1) Turn the instrument "ON" and allow a warm-up period of at least 5 minutes.

(2) Connect to the input a stable ac source of about 10 volts peak-to-peak at any convenient frequency from 100 to 10,000 cps.

(3) Set the range switch at 10.

(4) Adjust the input voltage to obtain a scale reading of 10.

(6) Adjust the RANGE ADJ screw on the right-hand side of the panel to obtain a scale reading of 1.

(7) Repeat steps (3) through (6) until no further adjustment is required.

If a source of 10 volts is not available, a 100 volt, a 1 volt or a .1 volt source may be used with range switch settings of 100 and 1000, 1 and 10, or .1 and 1 respectively.

Greater accuracy in scale range adjustment may be had by using only one voltage range setting and an external precision 10:1 potential divider which presents to the instrument a source impedance of not more than 2000 ohms. The procedure would then be as outlined except that level changes would be made with the potential divider instead of the range selector switch.

CALIBRATION ADJUSTMENT - Normally no attention need be given to the matter of calibration as the large amount of feedback in the instrument gives it sufficient inherent stability to maintain the calibration factory calibration within the accuracy specified. However, to correct errors which might result from the cumulative effect of wide variations in characteristics of replacement tubes from average tubes, a variable control has been provided which allows the calibration to be shifted a small amount. This control is accessible at the rear of the chassis (near the power cord) when the outer box is removed.

In adjusting the calibration of the instrument the source voltage should be a pure sinusoidal wave of any convenient frequency from 100 to 10,000 cps, and the rms indicating voltmeter used as a standard should be accurate to at least 1% at the selected test frequency.

It should be remembered in comparing the calibration of this instrument with other voltmeters that the indication of the Model 305 is peak-to-peak volts. Therefore, for a pure sinusoidal wave input the Model 305 will read 2.83 times the rms value indicated on a normal ac voltmeter.

REPLACING OF INCANDESCENT LAMPS - Lamps may be replaced after removing the cover of the indicating meter by unscrewing the two holding screws on the top of the meter cover. Care should be taken to avoid disturbing the hairspring adjusting screws inside the meter case. The scale calibration is critically dependent on this setting.

REPLACEMENT OF FUSE - The fuse is a 1A0, one ampere, cartridge type and is located adjacent to the power cord entrance to the instrument. It unscrews easily without removal of the chassis from the case. A spare fuse is supplied.

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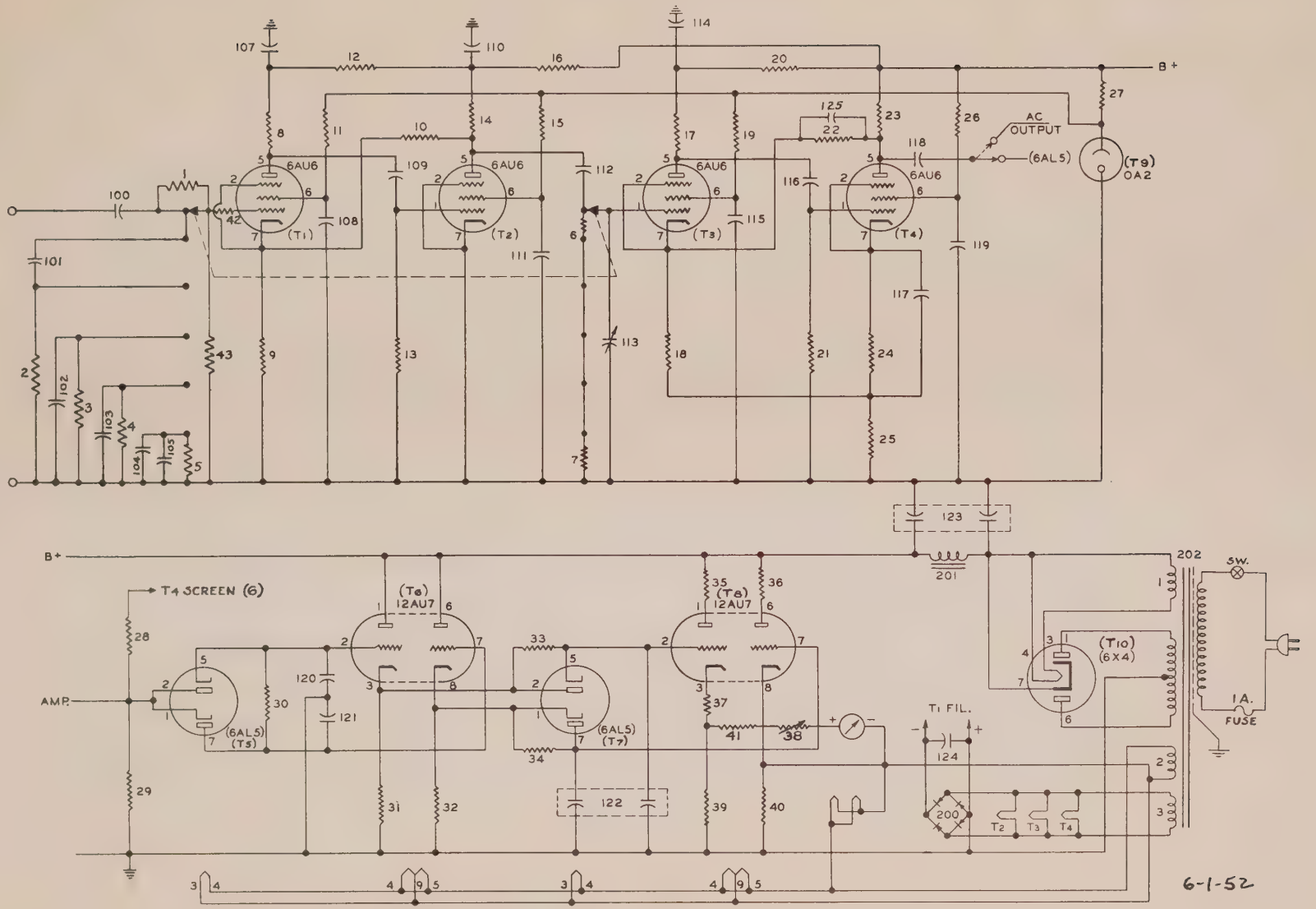
SCHEMATIC CIRCUIT DIAGRAM
MODEL 305
PEAK READING VOLTMETER



REFERENCE LIST OF PARTS *

Ref. No.		
	RESISTORS	
1	2 megohms, Type CP-1,	Wilkor Products, Inc.
2	250,000 ohms, Type CP-½,	Wilkor Products, Inc.
3	20,400 ohms, Type [illegible]	Wilkor Products, Inc.
4	2,000 ohms, Type [illegible]	Wilkor Products, Inc.
5	200 ohms, Type [illegible]	Wilkor Products, Inc.
6	1 megohm, Type [illegible]	Wilkor Products, Inc.
7	111,100 ohms, Type [illegible]	Wilkor Products, Inc.
8	47,000 ohms, Type [illegible]	Wilkor Products, Inc.
9	2,000 ohms, Type [illegible]	Wilkor Products, Inc.
10	170,000 ohms, Type [illegible]	Wilkor Products, Inc.
11	68,000 ohms, Type [illegible],	Allen-Bradley Company
12	100,000 ohms, Type [illegible],	Allen-Bradley Company
13	10 megohms, Type [illegible],	Allen-Bradley Company
14	27,000 ohms, Type [illegible],	Allen-Bradley Company
15	150,000 ohms, Type [illegible],	Allen-Bradley Company
16	100,000 ohms, Type [illegible],	Allen-Bradley Company
17	47,000 ohms, Type [illegible],	Allen-Bradley Company
18	2,000 ohms, Type [illegible],	Wilkor Products, Inc.
19	220,000 ohms, Type [illegible],	Allen-Bradley Company
20	100,000 ohms, Type [illegible],	Allen-Bradley Company
21	470,000 ohms, Type [illegible],	Allen-Bradley Company
22	200,000 ohms, Type [illegible],	Wilkor Products, Inc.
23	22,000 ohms, Type [illegible],	Allen-Bradley Company
24	200 ohms, Type [illegible],	Allen-Bradley Company
25	Approx. 18 ohms, Type 172,	Special Wire Wound
26	47,000 ohms, Type [illegible],	Allen-Bradley Company
27	27,000 ohms, Type [illegible],	Allen-Bradley Company
28	10 megohms, Type [illegible],	Allen-Bradley Company
29	6.8 megohms, Type [illegible],	Allen-Bradley Company
30	22 megohms, Type [illegible],	Allen-Bradley Company
31	18,000 ohms, Type [illegible],	Allen-Bradley Company
32	18,000 ohms, Type [illegible],	Allen-Bradley Company
33	10 megohms, Type [illegible],	Allen-Bradley Company
34	10 megohms, Type [illegible],	Allen-Bradley Company
35	100 ohms, Type [illegible],	Allen-Bradley Company
36	100 ohms, Type [illegible],	Allen-Bradley Company
37	1,000 ohms, Type J Volume Control,	Allen-Bradley Co.
38	200,000 ohms, Type J Volume Control,	Allen-Bradley Co.
39	18,000 ohms, Type GB,	Allen-Bradley Company
40	18,000 ohms, Type GB,	Allen-Bradley Company
41	225,000 ohms, Type CP-½,	Wilkor Products, Inc.
42	1,000 ohms, Type EB,	Allen-Bradley Company
43	2 megohms, Type CP-1,	Wilkor Products, Inc.
44	68,000 ohms, Type EB,	Allen-Bradley Company

* See attached wiring diagram.

REFERENCE LIST OF PARTS *

Part No.		CONDENSERS		
100	-	.05 mfd.,	600 Volt,	Cornell-Dubilier PUP
101	-	0.68 mmfd.,		Stackpole Type GA-1
102	-	7-45 mmfd.,	maximum,	Centralab Type 822BN
103	-	970 mmfd.,	maximum,	El-Menco X306
104	-	550-1600 mmfd.,	maximum,	El-Menco X309
105	-	.0025 mfd.,		Cornell-Dubilier Type 1W
107	-	40 mfd.,	300 Volt,	Sprague Type DFP
108	-	15 mfd.,	300 Volt,	Sprague Type DFP
109	-	.047 mfd.,	200 Volt,	Sprague Type 67P47302
110	-	40 mfd.,	300 Volt,	Sprague Type DFP
111	-	15 mfd.,	300 Volt,	Sprague Type DFP
112	-	.1 mfd.,	200 Volt,	Sprague Type 67P10402
113	-	1-8 mmfd.,	Tubular Trimmer,	Erie Style 532
114	-	15 mfd.,	450 Volt,	Sprague Type DFP
115	-	15 mfd.,	300 Volt,	Sprague Type DFP
116	-	.022 mfd.,	400 Volt,	Sprague Type 67P2-2304
117	-	100 mfd.,	25 Volt,	Sprague Type DFP
118	-	.1 mfd.,	400 Volt,	Sprague Type 67P10404
119	-	15 mfd.,	300 Volt,	Sprague Type DFP
120	-	50 mmfd.,	Tubular Ceramicon,	Erie Type GP1K
121	-	50 mmfd.,	Tubular Ceramicon,	Erie Type GP1K
122	-	2X - .25 mfd.,	400 Volt,	Sprague Type CPNB-48
123	-	10-10 mfd.,	450 Volt,	Sprague Type DFP
124	-	1,000 mfd.,	6 Volt,	Sprague Type DFP
125	-	0.68 mmfd.,		Stackpole Type GA-1

200 - Selenium Rectifier, Type P1B1S1A, Ballantine Labs.
201 - Filter Choke, Type 79-26R, Ballantine Labs.
202 - Power Transformer, Type 97-25R, Ballantine Labs.

* See attached Wiring Diagram.

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